THE LINKAGE RELATIONS OF A NEWLY ISOLATED nana MUTANT

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The mutant nana (na) was discovered and described by Wellensiek (8). Later he reported its linkage relations on chromosome 6 (9). Murfet (5) offered additional evidence in support of the location as to chromosome and described the interaction with the Le locus; na was shown to be epistatic to Le as well as to le.

In 1979 an extremely dwarf plant resembling Wellensiek's nana appeared in one of my Arg progenies, an F4. All remaining plants in the progeny were normal dwarfs (le/le). The line also was homozygous for b, sil, wlo, and Pl (in addition to Arg). Progeny tests of this plant confirmed that the short stature was genetic in origin and visual comparisons with Wellensiek's nana (WL-1766) grown under the same conditions reaffirmed the phenotypic similarities between the two lines.

WL-1766 was then crossed with the Geneva nana to test the genotypic relationship. All F1 plants derived from crosses between the two lines expressed the nana phenotype indicating the na gene in my line represents a reoccurrence of the original na but in this case the gene is combined with le rather than with Le as is the case in WL-1766. A very small consisting of 24 plants was grown from this cross for further confirmation that the two genes were "identical". Although all the F2 plants apparently were phenotypically nana, three classes of height were evident: roughly speaking, (i) very tiny and compact, (ii) slightly taller but clearly na, and (iii) taller plants approaching the height of very short dwarf (le) plants. In another context, the latter group of plants could easily have been mistaken for short dwarfs. This observation together with the observation that na segregants from the F2 and F3 populations discussed below were not all of equal height (at least two distinct height classes), implied that other gene loci, perhaps La and Cry, interact with na and influence internode length and final height. Moreover, all populations studied showed rather clearly that the slightly taller na segregants were consistently more vigorous and productive than the shorter na segregants. It is tempting to speculate that plants with the combination na/na Le/Le are shorter and less productive than those with the combination na/na le/le. However, all crosses involving WL-1766 showed some degree of semi-sterility whereas crosses with the Geneva na were fully fertile.

Two other crosses were analyzed more comprehensively. In these, tl> two sources of na were again involved, the one isolated at Geneva being identi-- fied as na (Marx) and the na isolated by Wellensiek being designated na (Well.) (WL-1766). However, the second parent in each of these crosses was Na. The relevant genotypes of the first cross were:

le Na Wlo arg pl x le na (Marx) wlo Arg Pl

The F_2 and F_3 populations derived from this cross are identified as B280-546-556 and C380-54-86, respectively, in Table 1. The second cross was of the constitution:

Le na (Well.) Wlo arg Pl x le Na wlo Arg Pl

The F_2 and F_3 populations derived from this cross are identified as B280-557-562 and C380-91-115, respectively, in Table 1.

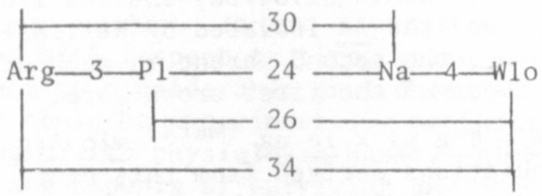
Table 1. Phenotype frequencies and estimates of percentage recombination among four gene loci (Na, Wlo, Arg, Pl) in chromosome 6.

Population	Gene Pair	Phenotype frequency AB	Ab	aB	ab	N	Phase	Chi-square (3:1)[1/] A	B	Recomb. Fract.	S.E.	Gener-ation	Source of na[2/]
B280-245-256	Arg-Pl	172	3	3	55	233	C	n.s.	n.s.	2.6	1.1	F_2	
B280-245-256	Arg-Na	126	56	55	5	242	R	"	"	28.8	5.8	F_2	M
B280-557-562	"	79	9	16	15	119	C	"	"	24.1	4.6	F_2	W
C380-54-86	"	197	90	100	11	398	R	"	"	30.7	4.5	F_3	M
C380-91-115	"	153	26	37	21	237	C	"	"	34.0	3.9	F_3	W
B280-245-256	Arg-Wlo	125	57	53	7	242	R	"	"	33.0	5.6	F_2	
B280-557-562	"	59	29	29	0	117	R	"	"	18.0	8.8	F_2	
C380-54-86	"	192	76	96	13	377	R	"	"	35.2	4.4	F_3	
C380-91-115	"	106	54	52	1	213	R	"	"	13.4	6.7	F_3	
B280-245-256	Pl-Na	123	54	53	3	233	R	"	"	23.6	6.1	F_2	M
B280-245-256	Pl-Wlo	121	53	55	4	233	R	"	"	26.4	6.0	F2	
B280-245-256	Wlo-Na	175	6	3	58	242	C	"	"	3.5	1.2	F_2	M
B280-557-562	"	66	29	22	0	117	R	"	"	21.4	8.7	F2	W
C380-54-86	"	407	17	16	114	544	C	"	"	6.3	1.1	F3	M
C380-91-115	"	159	58	71	0	288	R	"	"	13.6	5.7	F_3	W

1/ Chi-square values marked n.s. give P values greater than 0.05.

2/ The populations designated with "M" segregated for the na gene isolated by Marx and those marked with "W" refer to those involving the na gene isolated by Wellensiek and present in WL-1766.

The F1's from the first cross were normal dwarfs (le) whereas F1's from the second cross were tall (Le/-). Most of the linkage estimates are consistent with each other within this study and with other published results. The percentage recombination between Arg-Wlo was, however, uncharacteristically low in the F_2 and F3 populations involving WL-1766 which, as mentioned, showed evidence of partial sterility. The two sources of na appear to map to the same site, thus supporting the results of the identity/allelism test. It seems safe to conclude on the basis of all the evidence thus far collected that Na, wlo, Arg, and Pl are all located in chromosome 6, with na being situated at the wlo end of the chromosome. This suggests the following rough and tentative map:



Wellensiek (9) reported a recombination value of 29.6% between na and fl, the latter gene being situated close to Pl. Murfet found the dominant gene for early flowering, E, to be linked with p_ (3) and with wlo (6), with CrO values of 28 and 26.3, respectively. The recent finding (2) that art is situated in chromosome 6 further brightens the linkage picture for this chromosome.

A mutant controlling plant height and designated micro-dwarf (lm) by Rasmusson (7) shows close linkage with p and wlo on chromosome 6 (1). This raises the possibility that na and lm are identical or allelic. To test this possibility, na(Marx), with its linked markers, has been crossed with WL-1329, a line carrying lm in combination with cry^s.

1. Lindqvist, K. 1951. Hereditas 37:389-420.
2. Marx, G. A. 1981. PNL 13:38.
3. Murfet, I. C. 1971. Heredity 27:93-110.
4. Murfet, I. C. 1977. PNL 9:38.
5. Murfet, I. C. 1978. PNL 10:54-55.
6. Murfet, I. C. 1980. PNL 12:59.
7. Rasmusson, J. 1938. Hereditas 24:231-257.
8. Wellensiek, S. J. 1969. Z. Pflanzenphysiol. 60:388-402.
9. Wellensiek, S. J. 1972. PNL 4:60.